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TITLE: Method and apparatus for **load sharing** transceiver handlers in regional **processors** of radio communications systems

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Abstract Text - ABTX (1):

A method for significantly more effective use of regional **processor** devices connected to a central **processor** (e.g., a node in GSM/CME2O1) in a cellular radio communications system by introducing **load sharing** between regional **processor** devices, thereby redressing the problems of too high a regional **processor** device **load** and too low a regional **processor** device **load**.

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TITLE - TI (1):
Method and apparatus for **load sharing** transceiver handlers in regional **processors** of radio communications systems

Brief Summary Text - BSTX (3):
The present invention relates to a method of and apparatus for increasing the efficiency of transceivers used in a cellular radio communications system by introducing **load sharing** between regional **processor** devices.

Brief Summary Text - BSTX (5):
Typical telephone exchanges (such as AXE) are usually built around a powerful central **processor** (CP), supported by a number of simple regional **processors** (RP's). Conventionally, the central **processor** performs the complex tasks, while the regional **processors** are dedicated to simple routine tasks (such as scanning).

Brief Summary Text - BSTX (6):
Recent applications have changed the tasks of the regional **processors** to some degree. For example, the special needs in mobile communication have forced the regional **processors** to perform complex tasks (e.g., advanced locating calculations). This has created a demand for more powerful regional

processors. The latest generation of regional **processors** are quite powerful and are built with state-of-the-art microprocessor technology. Nevertheless, various applications are suffering from both 'too high' as well an 'too low' regional **processor loads**.

Brief Summary Text - BSTX (8):

A method for significantly more effective use of regional **processor** devices connected to a central **processor** in a cellular radio communications system by introducing **load sharing** between regional **processor** devices, thereby redressing the problems of too high a regional **processor** device **load** and too low a regional **processor** device **load**.

Brief Summary Text - BSTX (9):

Under the inventive method, **load sharing** between at least two regional **processor** devices in a radio communications system is achieved by the following steps. Each regional **processor** device reports **load** information, such as peak and/or average **loads**, at specified time intervals. **A load** monitor receives these **load** information reports from the regional **processor** devices and determines whether any regional **processor** devices have a high **load** at or higher than an upper limit or a low **load** at or less than a lower limit. If the **load** monitor determines that at least one regional **processor** device has a high **load** and at least one regional **processor** device has a low **load, then the load** monitor changes over at least one connection from the regional **processor** device with a high **load** to the regional **processor** device with a low **load**.

Brief Summary Text - BSTX (10):

The present invention achieves various advantages over the prior art such as more or less eliminating the risk for regional **processor** device overload for the vast majority of base station controller nodes.

Brief Summary Text - BSTX (12):

The present invention also permits a simplified introduction of current and future (and more powerful) regional **processor** devices into sites with older regional **processor** devices (which might be limited in function to the scanning).

Brief Summary Text - BSTX (13):

The present invention also permits the dynamic use of regional **processor** devices in time, capable of handling odd situations arising in the network.

Brief Summary Text - BSTX (14):

In prior art systems, the number of transceivers to regional **processor** devices is hard-wired to fit the average conditions for a 'nearly-worst-case' regional **processor** device situation. Regional **processor** devices incur such situations only occasionally, meaning equipment and space are not utilized to their best potential.

Brief Summary Text - BSTX (15):

With the inventive method described herein, the number of transceivers per regional **processor** device varies dynamically by time. The actual number is based on the current traffic and operation and maintenance situations.

Drawing Description Text - DRTX (4):
FIG. 2 is a functional block diagram of a cellular radio communications system in which the communication **loads** of the various regional transceivers is shown; and

Drawing Description Text - DRTX (5):
FIG. 3 is a flow chart of the **process** steps in accordance with the present invention.

Detailed Description Text - DETX (2):
The following exemplary embodiments will be described by way of illustration and not limitation. With reference to FIG. 1, a number of regional **processor** devices 14 (RPD1, RPD2 . . . RPDn) are connected to the central **processor** 15 through a group switch 16. The regional **processing** devices 14 are connected to a number of transceivers (TRX's) 17 located at the base station sites. The connections between the regional **processing** devices 14 and the transceivers 17 can be PCM lines, in accordance with standard GSM hardware.

Detailed Description Text - DETX (4):
A cellular radio communication system such as GSM may be basically divided into two sections; a Switching System (SS) 10 and, of interest to the present invention, a Base Station System (BSS) 12. The base station system 12 provides an air interface with a plurality of mobile stations (MS's) 19. The mobile stations 19 are the terminal equipment used by the subscriber.

Detailed Description Text - DETX (6):
The base station system 12 includes the regional **processor** devices 14 which provide the **processing** support for the base station controller 13 and a Base Transceiver Station (BTS) 18, which is the radio equipment needed to serve one cell. The base station transceiver 18 contains the aerial system, the radio frequency power amplifiers and all the digital signal **processing** equipment needed, including the transceivers 17.

Detailed Description Text - DETX (7):
The base station system 12 also includes a Base Station Controller (BSC) 13, which is the functional unit that controls and supervises the base station transceivers 17 and the radio connections in the system. In the CME 20 system, the base station controller 13 is implemented in a AXE 10 switch. The mobile switching center 11 is responsible for set-up and routing of calls to and from mobile subscribers. **A** lot of other functions are implemented in the mobile switching center 11, e.g., authentication and ciphering.

Detailed Description Text - DETX (8):
Each regional **processing** device 14 handles signalling and call supervision (e.g., locating) over a 64 Kbit/s PCM time-slot for up to four (4), or in some cases three (3), transceivers 17 under standard GSM system structure. The number of transceivers per regional **processor** device can vary between one and eight in current and envisioned implementations of GSM (while currently only three or four are used). The maximum of four is not a hard limit.

Detailed Description Text - DETX (9):
In base station controller applications, the regional **processor** devices 14 are often referred to Transceiver Handlers (TRH's), thus the title of the present invention.

Detailed Description Text - DETX (10):
The configuration rule above (i.e., three to four transceivers per regional **processor** device) is conventionally applied to all installed regional **processor** devices, with no regard to traffic (e.g., setting up, clearing and, to some degree the numbers of simultaneous calls (Erlang)) considerations. By applying such considerations, some interesting factors become clear.

Detailed Description Text - DETX (11):
For a few regional **processor** devices, the risk for an overload is evident (resulting in a risk for faulty call supervision, lost calls, etc). This goes for regional **processor** devices in metropolitan areas in particular, where all the transceivers belong to heavy-duty channels which are likely to have traffic peaks coinciding in time. In such a case, occasionally one or two transceivers 17 might be enough per transceiver handler 14.

Detailed Description Text - DETX (12):
On the other hand, for a large number of regional **processing** devices (most likely the majority), the risk of too low a **load** is evident (resulting in a wasted equipment expense and space). This is especially true in rural areas, where transceiver quantities are large due to the large areas covered rather than traffic handling reasons. In such cases, a maximum number of twenty transceivers per regional **processor,** for instance, might be appropriate.

Detailed Description Text - DETX (13):
For typical base station controller applications, a mixture of the cases above is expected. That is, while some regional **processor** devices 14 are overloaded at a certain time, the majority of the regional **processor** devices 14 are poorly utilized. **A** better division of transceivers per regional **processor** device seems advisable. However, as the traffic varies in time, the connections between transceivers and regional **processor** devices can not be hard-wired for optimization.

Detailed Description Text - DETX (14):
To solve these problems, a method and apparatus for **load sharing** between regional **processor** devices is described next.

Detailed Description Text - DETX (15):
Initially, a number of transceivers are connected to each regional **processing** device. With reference to the **load** situation shown in FIG. 2, assume the **load** of a first regional **processing** device RPD1 is rising, thereby indicating potential **load** problems. To address the **load** problems, a **load** monitor 25 is included in the central **processor** 15. The **load** monitor 25 is best suited for software implementation. This gives the best opportunities regarding operation and statistics, while having low **processing** demands.

Detailed Description Text - DETX (16):

The **load sharing** mechanism will now be described with references to the **process** steps of FIG. 3 (wherein the specific values are offered only by way of example):

Detailed Description Text - DETX (17):

(a) Each regional **processor** device reports the average (and/or peak) **load** for an elapsed time, e.g., at 5 minute intervals (Step 31). For example, a signal REP.sub.-- INT might be sent to a **load** monitor in the central **processor**.

Detailed Description Text - DETX (18):

(b) The **load** monitor updates a **load** list (Step 32), determines which transceiver has the highest **load** (step 33), and checks whether any regional **processor** device has reported a **load** above 80% (UPPER.sub.-- LIM), for example (step 34). If no regional **processor has a load** at or above the upper limit, the method returns to wait for more **load** reports (step 31).

Detailed Description Text - DETX (19):

(c) If a regional **processor** device is found to have a **load** at or above an upper limit, the **load** monitor finds the regional **processor** device with the lowest **load** (step 35), and checks whether there are any regional **processor** devices with a **load** below 30% (LOWER.sub.-- LIM), for example (step 36). If no regional **processor** device is found to have a **load** at or below the lower limit, then the method returns to await the next set of **load** reports (step 31).

Detailed Description Text - DETX (20):

(d) If a regional **processor** device with a low **load** is found (step 36), a change-over of one transceiver connection from the regional **processor** device with the highest **load** to the regional **processor** device with the lowest **load** is prepared (T1 from RPD1 to RPD2, for example)(step 37).

Detailed Description Text - DETX (21):

To make such a transfer as smooth as possible, the following measures are taken: (1) transfer of recent generations of reported measurement data (for transceiver connection TRX T1) from a first regional **processor** device RPD1 to a second regional **processor** device RPD2, and (2) **loading** of relevant cell data (for TRX T1) from the central **processor** to the second regional **processor** device RPD2. The measurement data is reported every 0.48 seconds, for example, and may include data on signal strength of a received signal, signal quality (e.g., bit error rate) of received signal, transmitting power used, signal strength of up to six neighboring cells, information regarding whether discontinuous transmission/reception is in use, etc.

Detailed Description Text - DETX (22):

(e) When the second regional **processor** device RPD2 is prepared to take over the connection T1 from the first regional **processor** device RPD1, a change-over is executed (through the group switch)(step 38).

Detailed Description Text - DETX (23):

(f) Steps (a) to (d) above (steps 33-38 in FIG. 3) are repeated to transfer a transceiver from a regional **processor** device with the second highest **load** to

a regional **processor** device with the second lowest **load,** etc.

Detailed Description Text - DETX (24):
The change-over of transceiver connections from one regional **processor** device 14 to another can be compared to when a redundant regional **processor** device is connected at a regional **processor** device failure (which is a capability of current base station controllers). In this case, the disturbance an traffic is estimated to be quite low. However, for the case described herein, the traffic disturbance will be even less (perhaps virtually zero). The reason is that the target regional **processor** device will be prepared by data transfers prior to the changeover.

Claims Text - CLTX (1):
1. In a radio communication base station system among a plurality of base station systems, said base station systems including at least two regional **processor** devices, each for a number of radio unit connections, at least one regional **processor** device serving a first plurality of transceivers having high traffic demands and at least another regional **processor** device serving a second plurality of transceivers having low traffic demands, a method for **load sharing** between said at least one regional **processor** device and said at least another regional **processor** device, comprising the steps of:

Claims Text - CLTX (2):
reporting from each regional **processor** device **load** information for that specific regional **processor** device and at specific time intervals,

Claims Text - CLTX (3):
determining, in a **load** monitor receiving said **load** information reports from each of said regional **processor** devices, whether any regional **processor** device has a high **load** not less than an upper limit or a low **load** not greater than a lower limit; and,

Claims Text - CLTX (4):
if said at least another regional **processor** device serving said second plurality of transceivers is determined by said **load** monitor to have a low **load,** changing over at least one connection from said one regional **processor** device serving said first plurality of transceivers to said another regional **processor** device serving said second plurality of transceivers.

Claims Text - CLTX (5):
2. **A** method in accordance with claim 1, wherein said **load** information includes average **load** information, peak **load** information, or both average **load** information and peak **load** information.

Claims Text - CLTX (6):
3. **A** method in accordance with claim 1, wherein each regional **processor** device includes a plurality of transceiver units.

Claims Text - CLTX (7):
4. **A** method in accordance with claim 3, wherein said **load** information

includes **load** information specific to each of said transceiver units.

Claims Text - CLTX (8):
5. **A** method in accordance with claim 1, wherein said change-over step includes:

Claims Text - CLTX (9):
transferring recent reported measurement data for a transceiver connection from the regional **processor** device with a high **load** to the regional **processor** device with a low **load**; and

Claims Text - CLTX (10):
loading of relevant cell data of a transceiver connection to the regional **processor** device with a low **load,** to make such a transfer smooth.

Claims Text - CLTX (11):
6. **A** method in accordance with claim 1, wherein said method is carried out in a GSM cellular radio communication switch unit.

Claims Text - CLTX (12):
7. **A** radio communication base station system among a plurality of base station systems, said base station systems including regional **processor** devices, each for a number of radio unit connections, a first plurality of transceivers having high traffic demands and at least one regional **processor** device serving a second plurality of transceivers having low traffic demands, including means for reporting from each regional **processor** device **load** information at specific time intervals,

Claims Text - CLTX (13):
load monitoring means receiving said **load** information reporting from each of said regional **processor** devices for determining whether any regional **processor** device has a high **load** not less than an upper limit or a low **load** not greater than a lower limit; and

Claims Text - CLTX (14):
switching means for changing over at least one connection from the regional **processor** device serving said first plurality of transceivers to a connection from the regional **processor** device serving said second plurality of transceivers if at least one regional **processor** device serving said second plurality of transceivers is determined by said **load** monitor to have a low **load**.

Claims Text - CLTX (15):
8. **A** radio communication base station system in accordance with claim 7, wherein said **load** information includes average **load** information, peak **load** information, or both average **load** information and peak **load** information.

Claims Text - CLTX (16):
9. **A** radio communication base station system in accordance with claim 7,

wherein each regional **processor** device includes a plurality of transceiver units.

Claims Text - CLTX (17):

10. **A** radio communication base station system in accordance with claim 9, wherein said **load** information includes **load** information specific to each of said transceiver units.

Claims Text - CLTX (18):

11. **A** radio communication base station system in accordance with claim 7, wherein said switching means includes:

Claims Text - CLTX (19):

means for transferring recent reported measurement data for a transceiver connection from the regional **processor** device with a high **load** to the regional **processor** device with a low **load**; and

Claims Text - CLTX (20):

means for **loading** of relevant cell data of a transceiver connection to the regional **processor** device with a low **load**, to make such a transfer smooth.